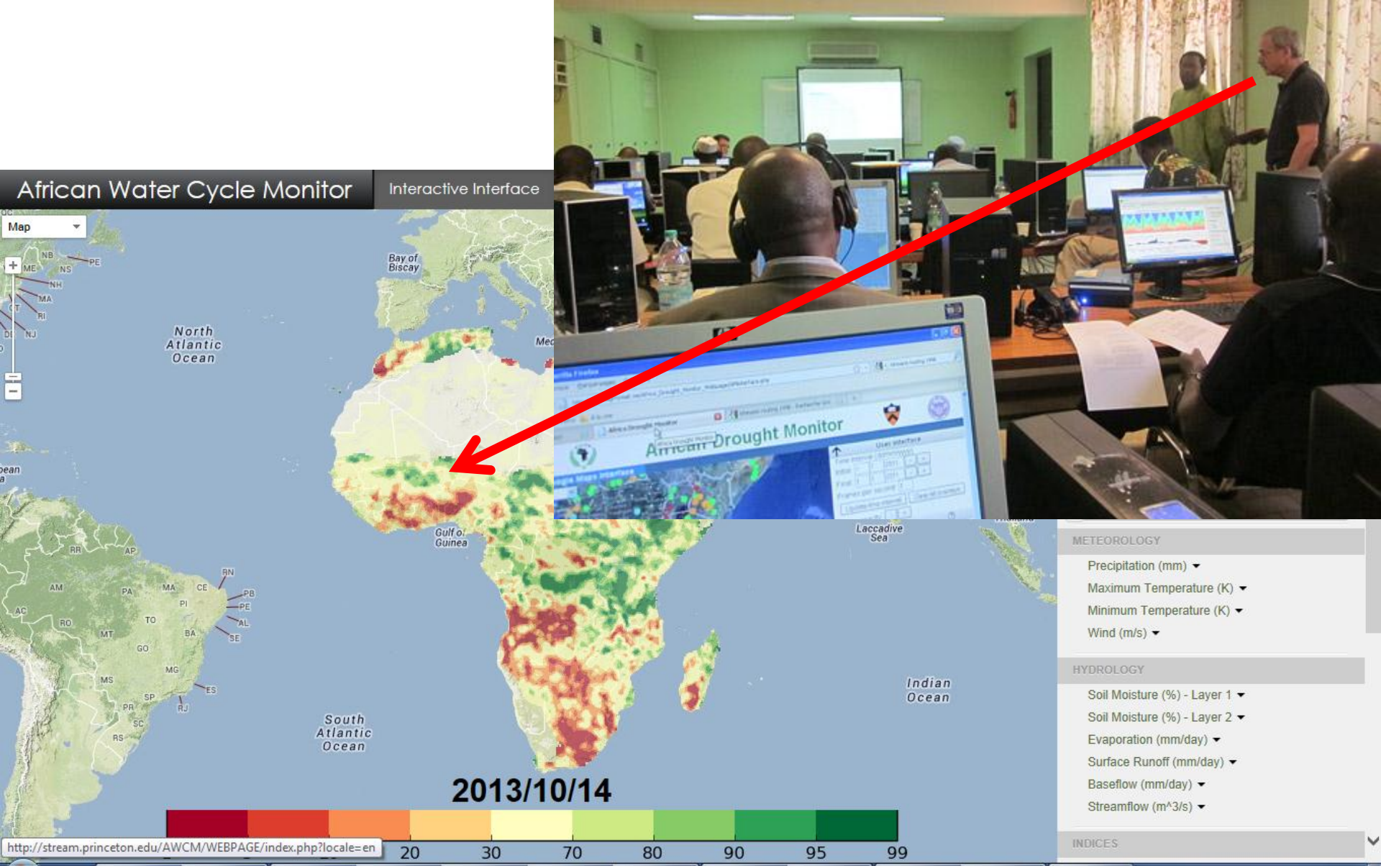
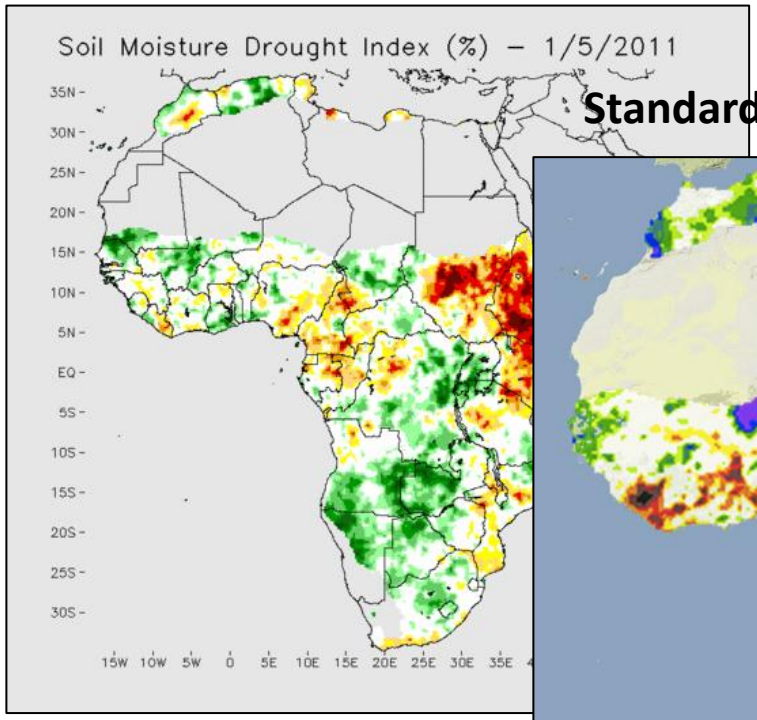


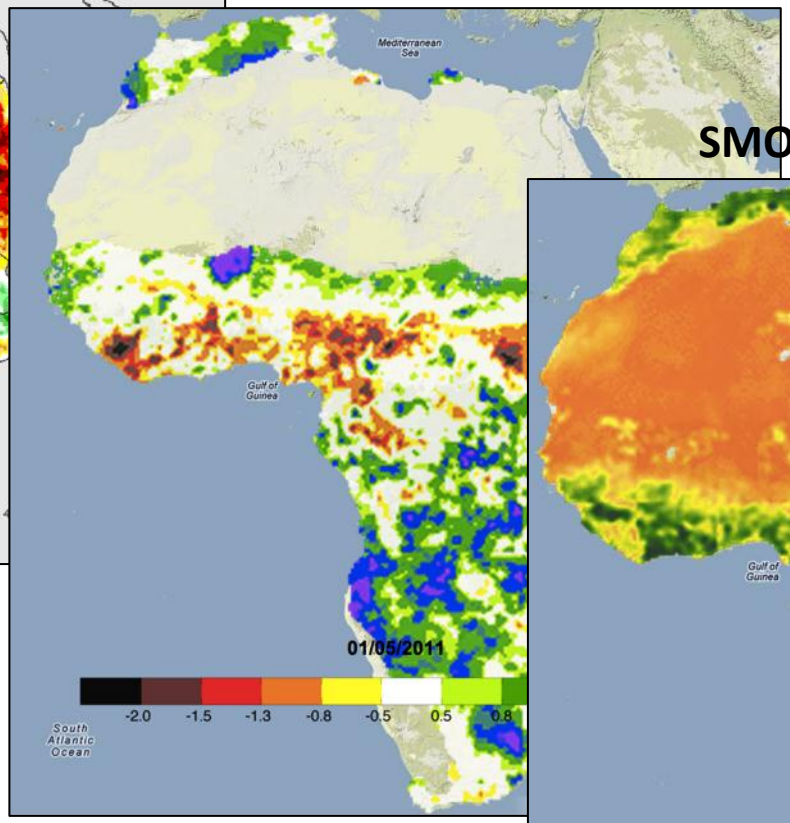
Princeton has developed a new African Water Cycle Monitor

African drought monitoring products

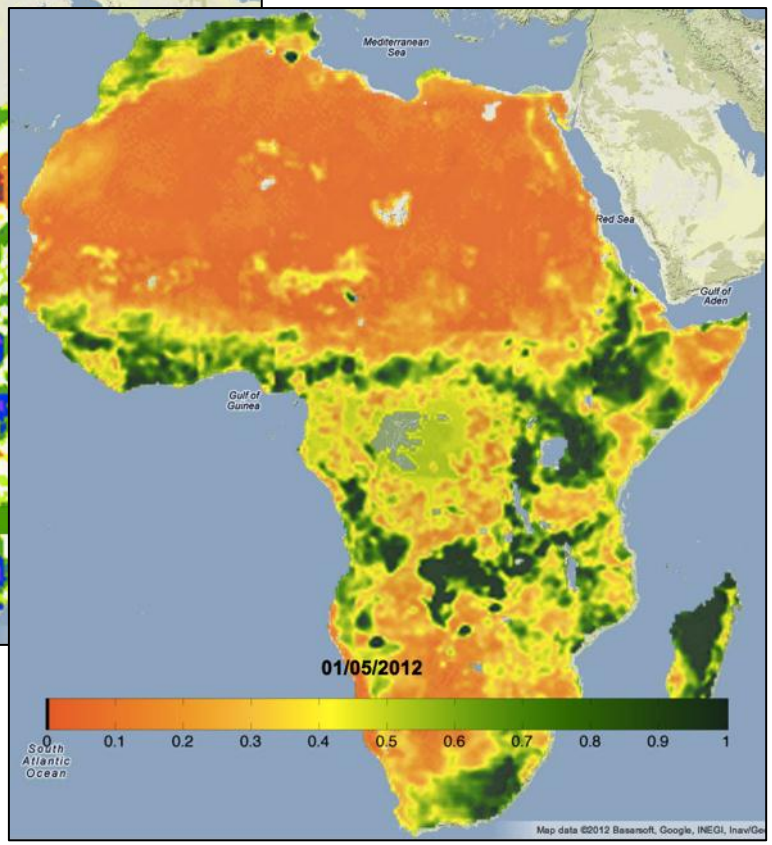
Soil Moisture (VIC) Drought Index



Standard Precipitation Index (SPI)

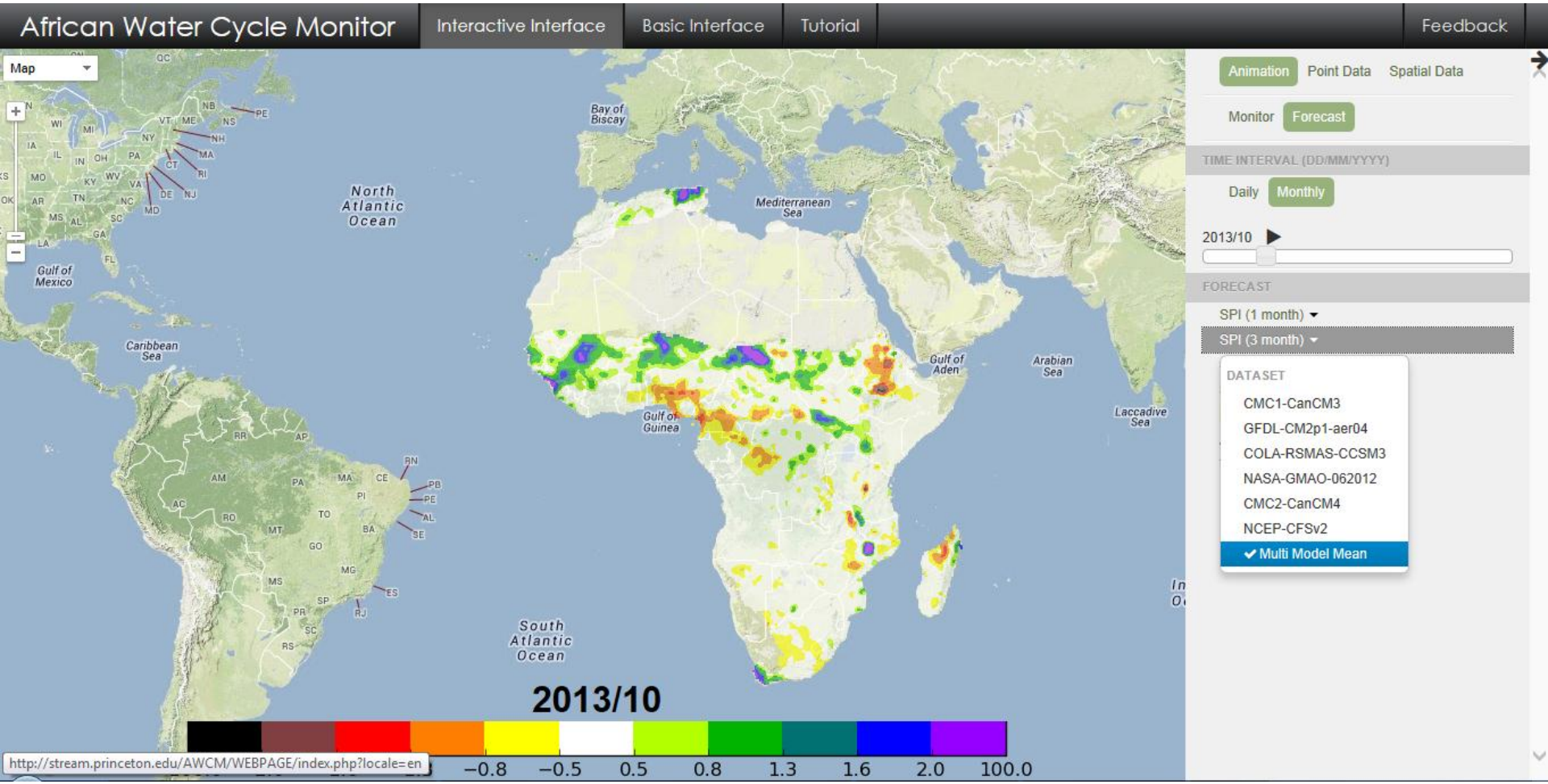


SMOS-SARI Index



DEI SVB NVMINE VIGET

NMME seasonal (SPI) forecast



We are now incorporating NMME into the system

Thank IRI for making NMME available to the community.

A NMME-based global seasonal hydrologic forecasting system

Eric Wood

Xing Yuan, Joshua Roundy, Justin Sheffield, and Ming Pan

Department of Civil and Environmental Engineering, Princeton University

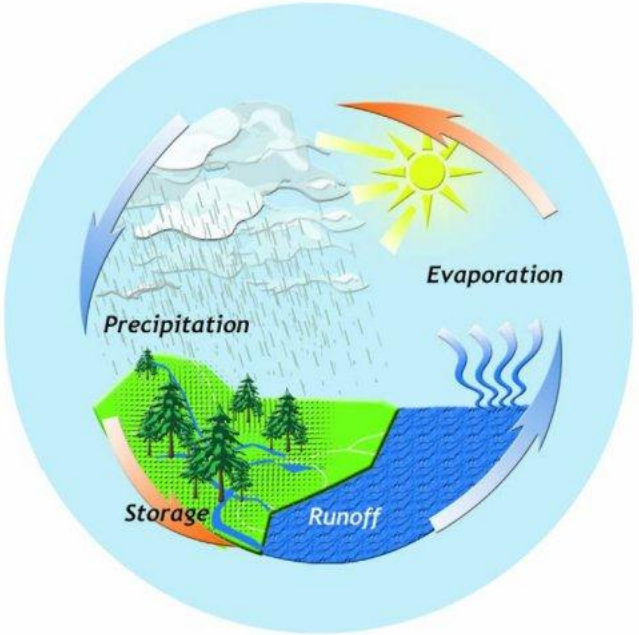
NOAA's 38th Climate Diagnostic and Prediction Workshop

College Park, MD, Oct. 21-24, 2013

Acknowledgement: NOAA Climate Program Office Grants NA10OAR4310246 and NA12OAR4310090.

Global Energy and Water Exchanges Project (GEWEX)

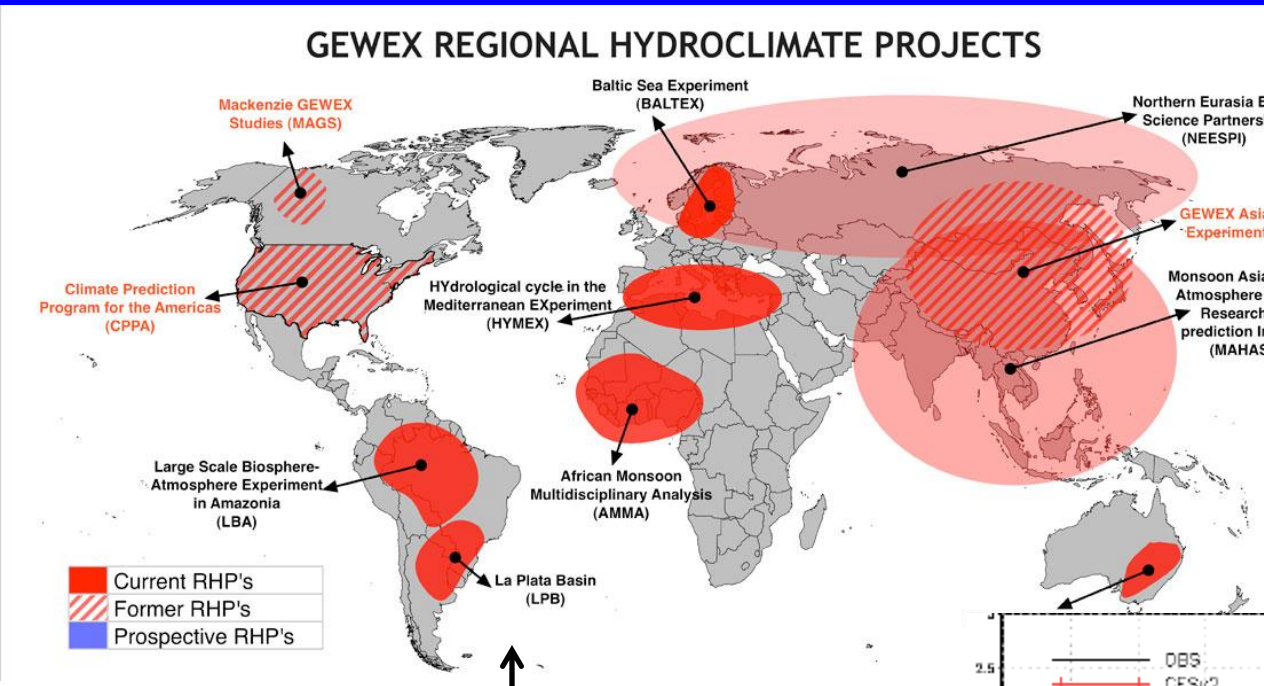
Mission: To observe, understand and **model** the hydrological cycle and energy fluxes in the Earth's atmosphere and at the surface.

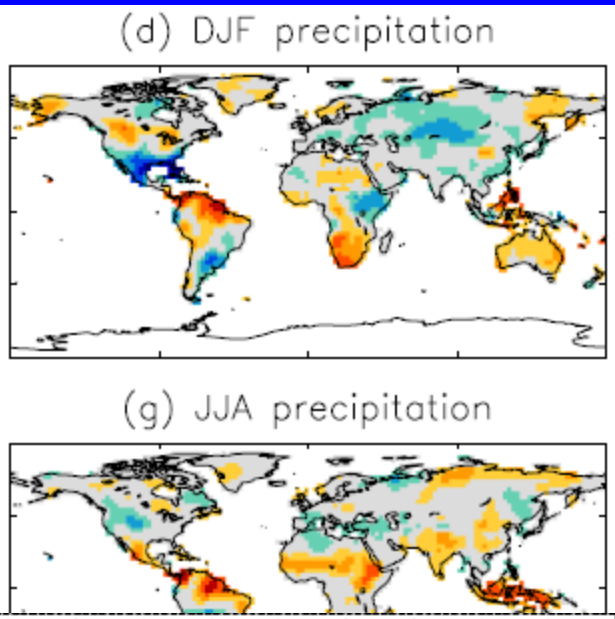


GEWEX Research Foci

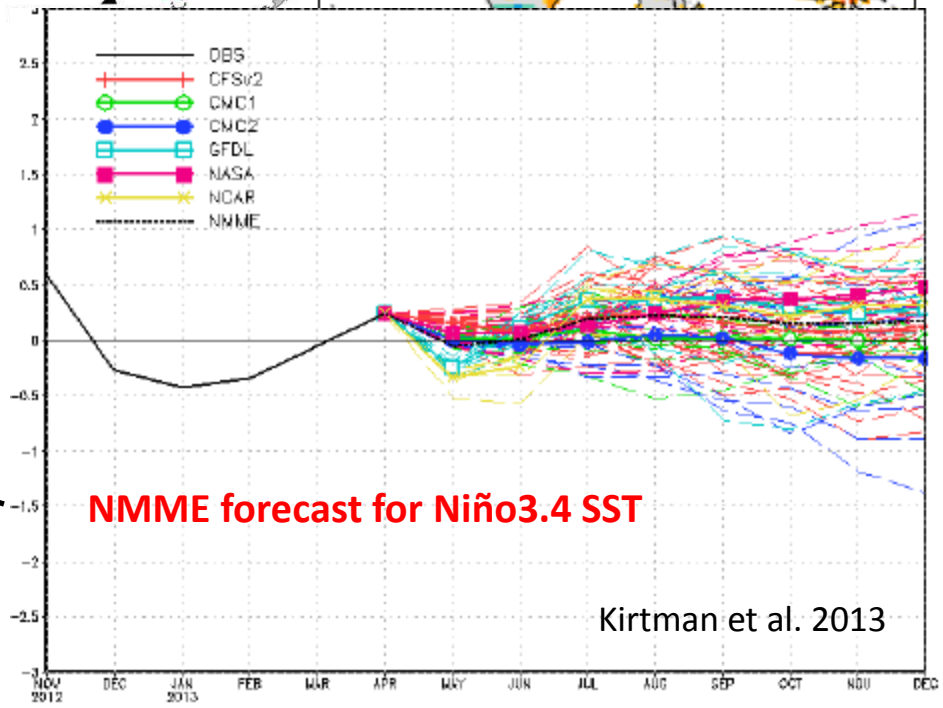
- Data and Assessment
- **Hydroclimatology - Demonstrate - in particular at the regional scale - skill in predicting changes in water resources and soil moisture on time scales up to seasonal and annual as an integral part of the climate system.**
- Modeling and Prediction

GEWEX/RHP and NMME





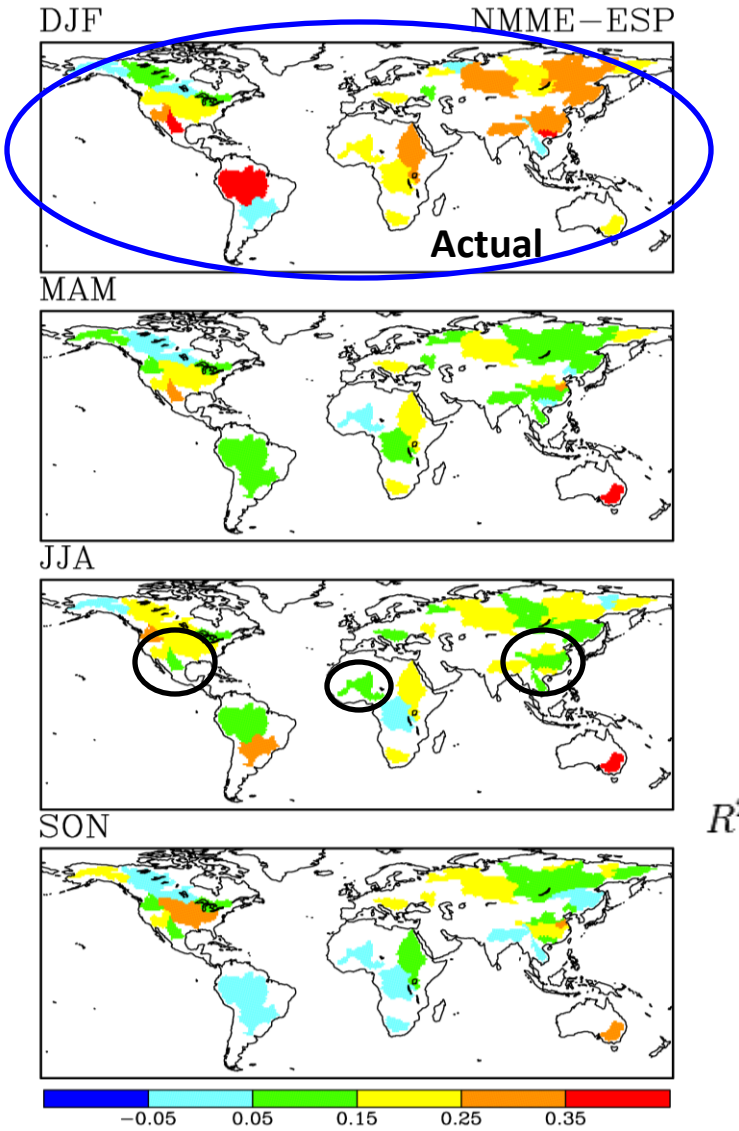
There is an opportunity to advance RHP by taking advantage of NMME.



NMME forecast for Niño3.4 SST

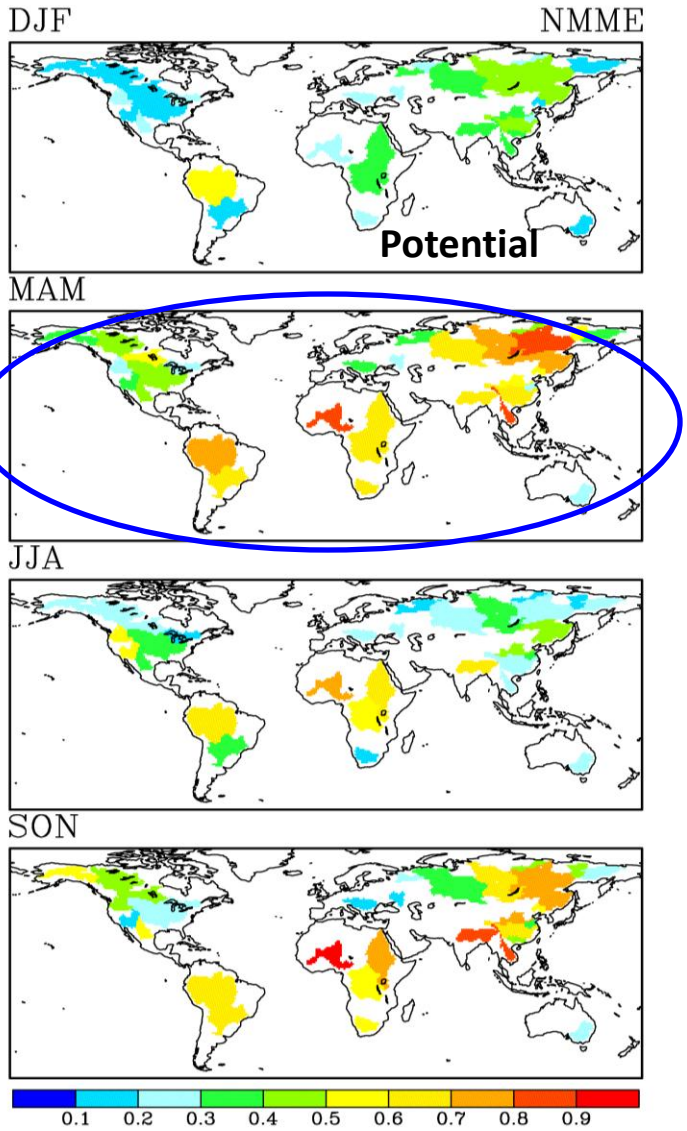
Kirtman et al. 2013

Actual and potential predictability of NMME (bias corrected) precipitation over GEWEX basins



Month-1 forecast

$$R^2 \equiv 1 - \frac{SS_{\text{res}}}{SS_{\text{tot}}}$$



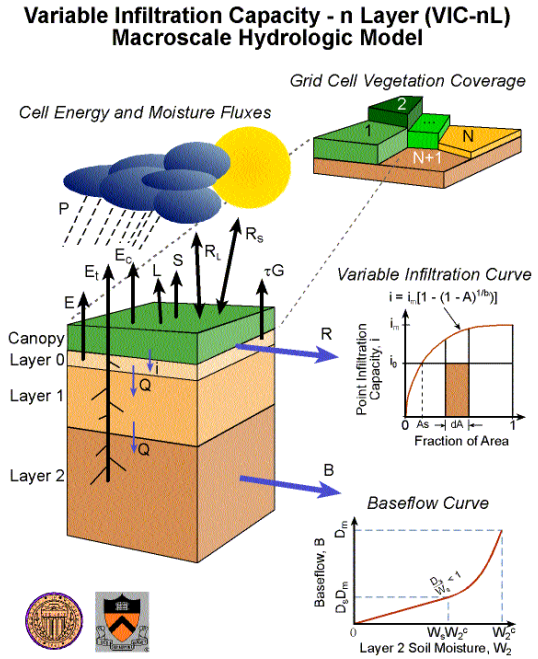
R^2 difference (predictability beyond climatology)

How well does the NMME predict itself (ens mean)

15,288 year Hydrologic hindcasts

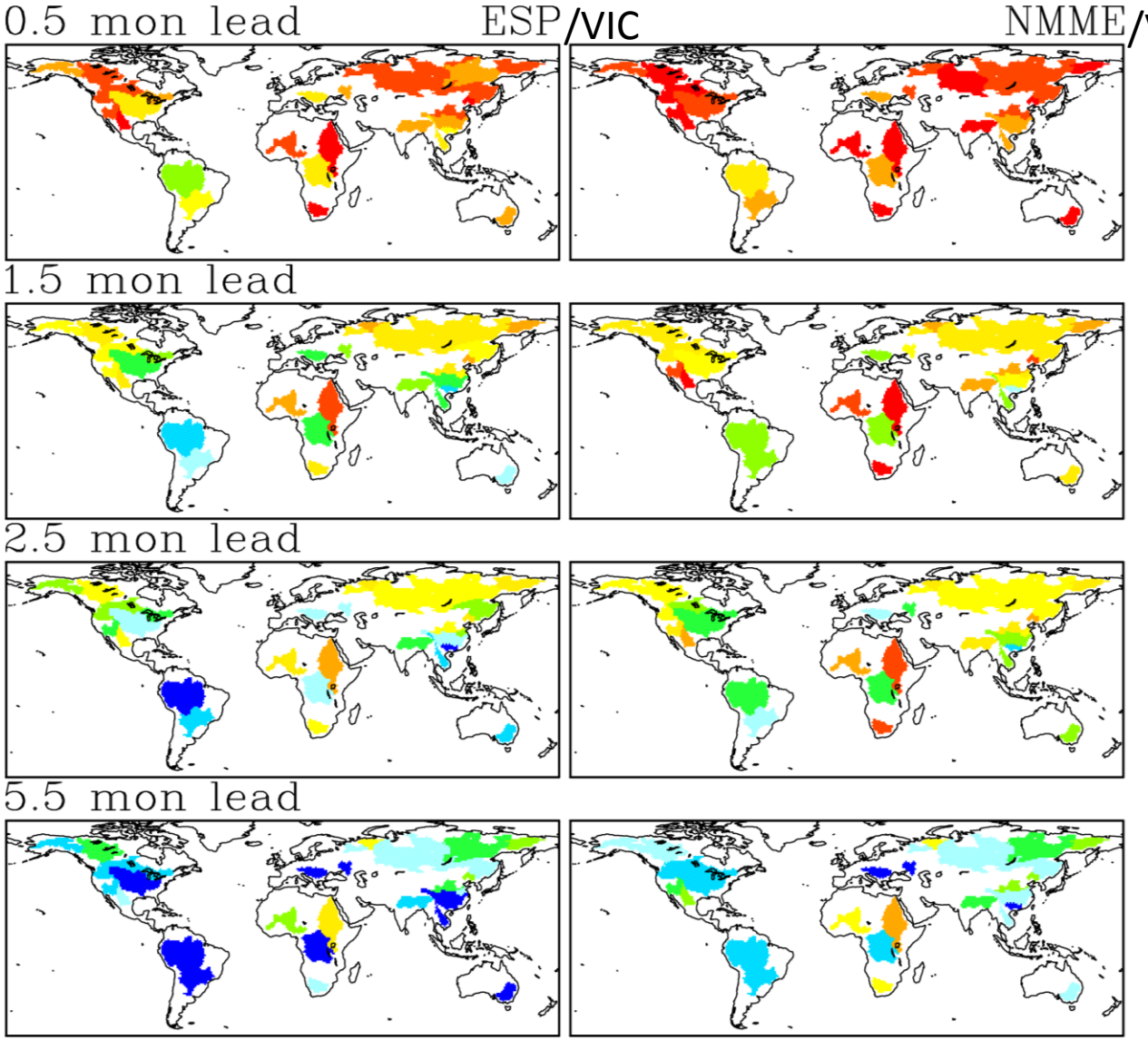
6-month hydrologic hindcasts starting from the 1st day of each calendar month during 1982-2009 for ESP (20 ensemble) and NMME (71 ensemble from 6 models)

Jan 82 Feb 82 Mar 82 Apr 82 May 82 Jun 82 Jul 82 ..... Nov 2009 Dec 2009



0.5(fcst)x12(mon)x28(yr)x91(ens) = 15,288 year NMME/VIC global integrations have been done over the supercomputer platform at Princeton.

Bias of soil moisture drought (1 month duration) forecast



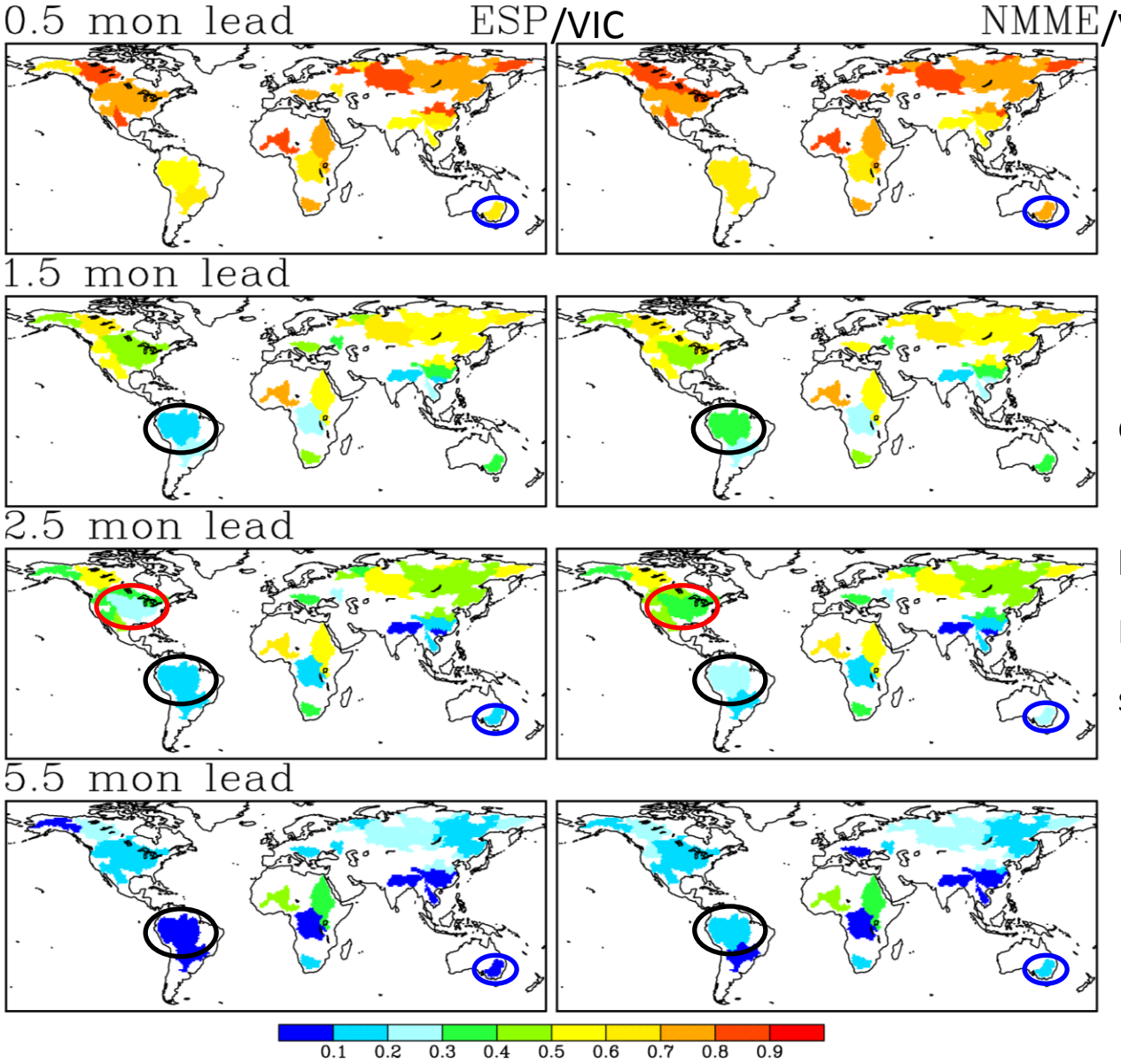
Hindcasts during 1982-2009

Ensemble median

Drought: Soil moisture percentile <20%

Bias=fcst/obs

Bias of soil moisture wet spell (1 month duration) forecast

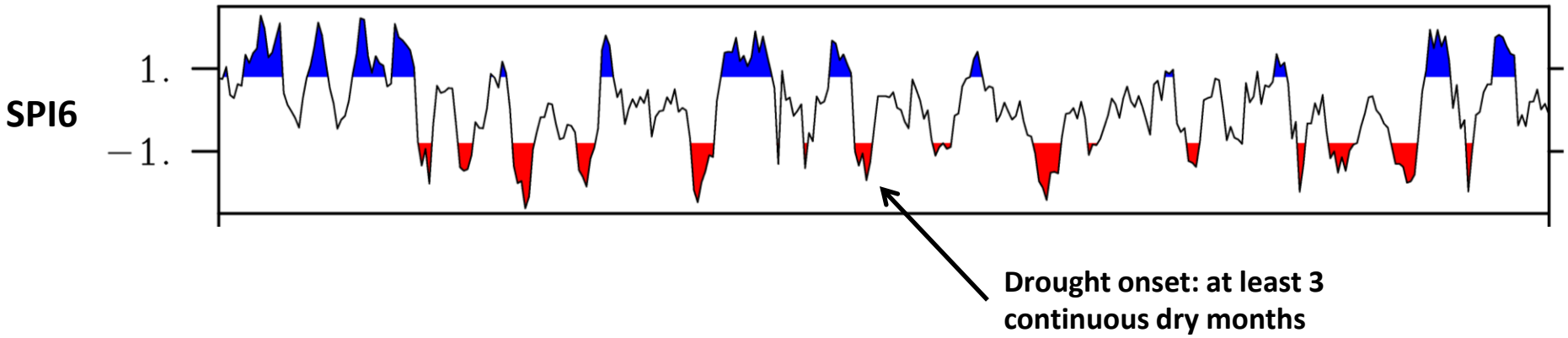


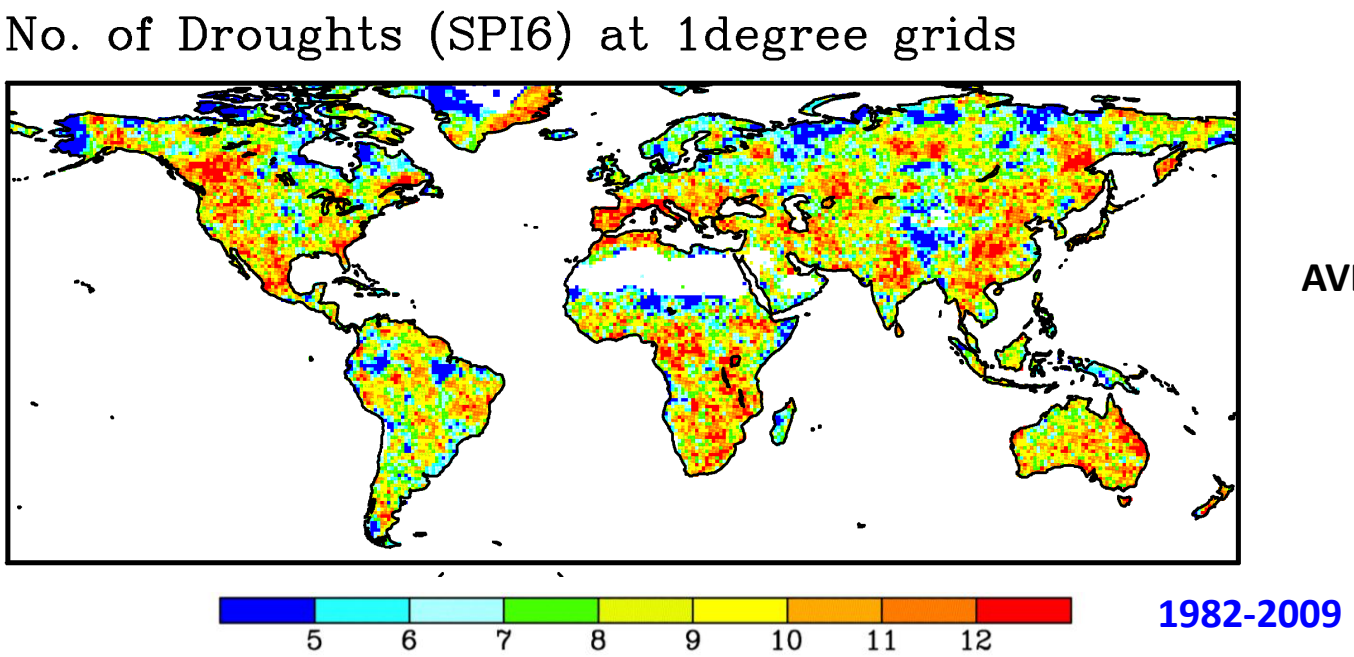
- Poorer than the drought forecast
- Differences between ESP and NMME are smaller

Wet spell: Soil moisture percentile >80%

Bias=fcst/obs

Multimodel seasonal forecasting of global drought onset



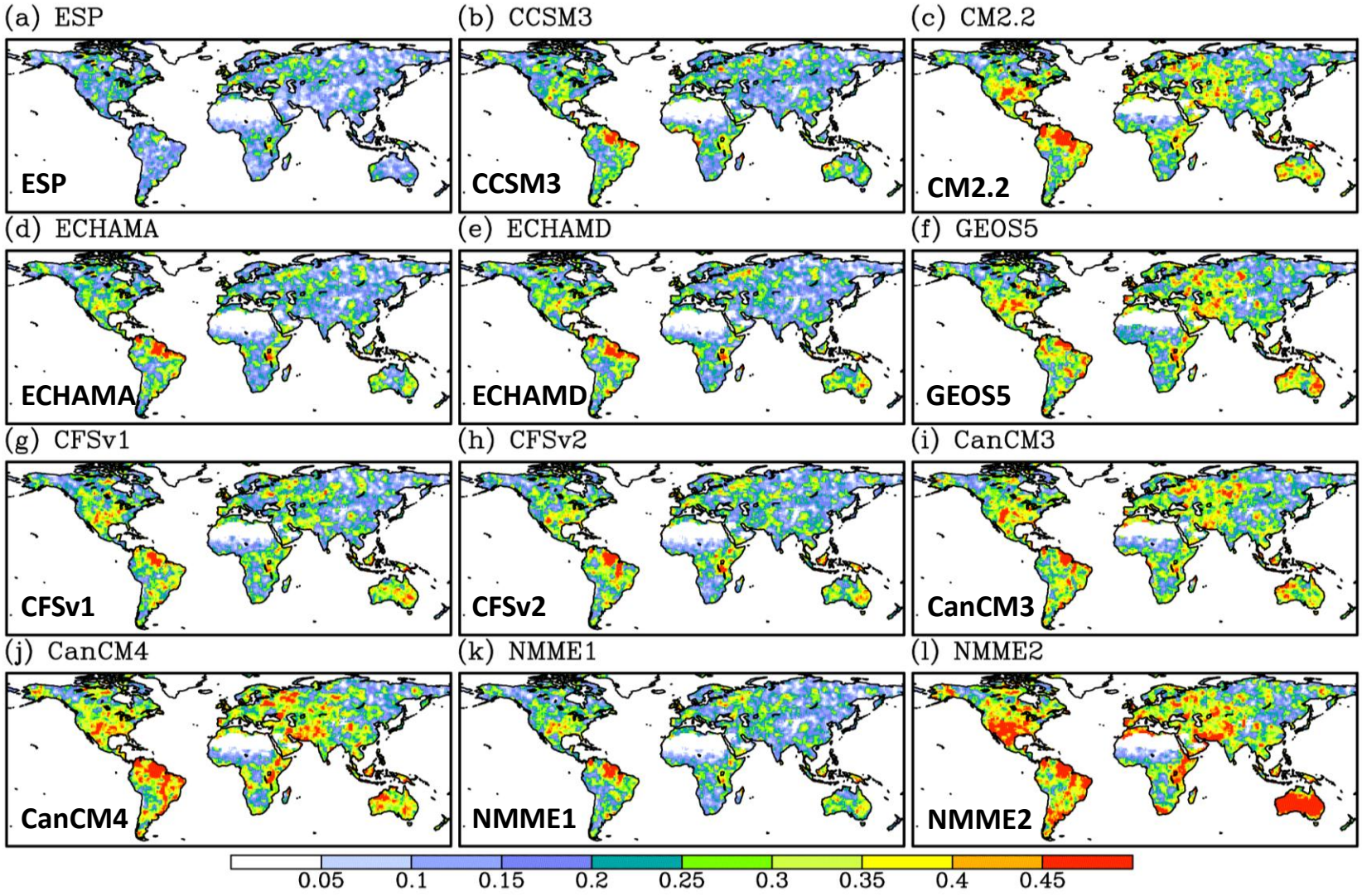


AVE=8.7

1982-2009

Evaluate drought forecast grid by grid, and event by event

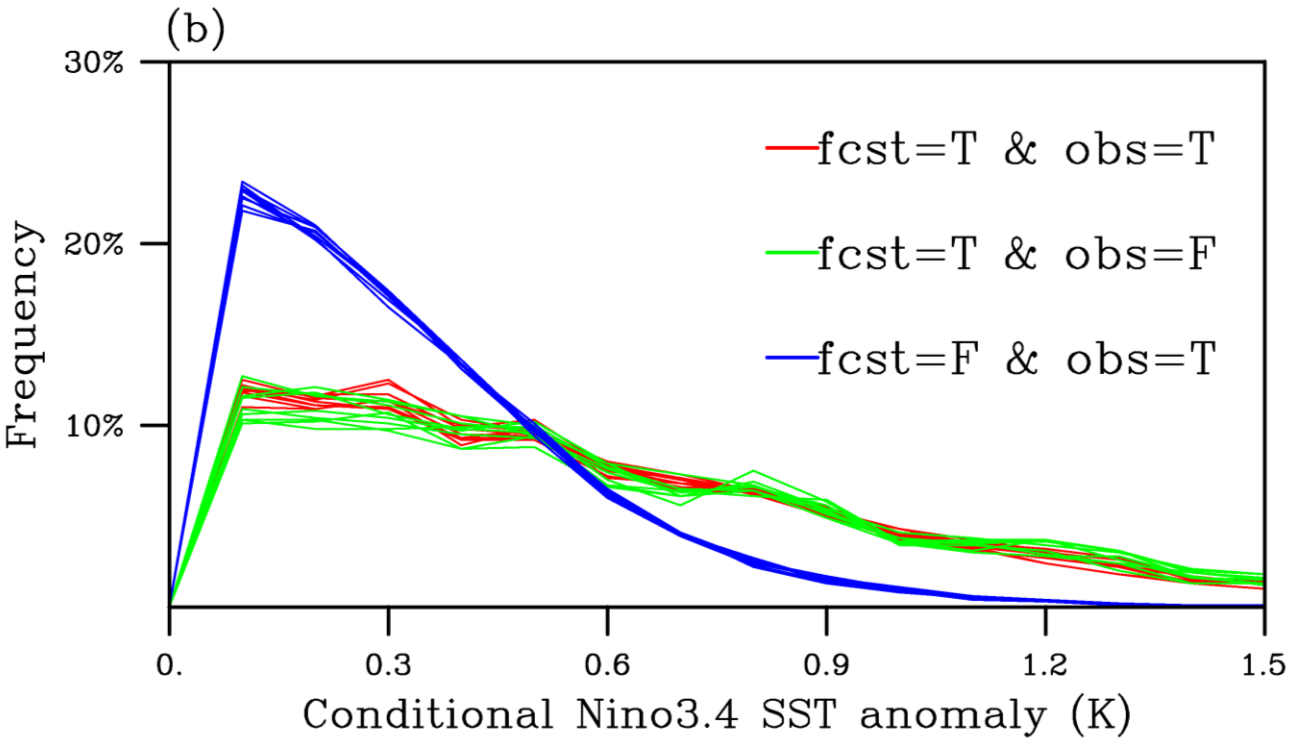
Probability of detection $p(y_1|o_1)$ for drought (SPI6) onset forecast



- ESP approach can only detect less than 20% of the observed drought onset events
- Climate models add values: central US, NE Brazil, East Africa, Europe, S China, and Australia
- Multi-model ensemble improves the forecast where individual models have high skill

Yuan and Wood, GRL, 2013

Frequency distributions of Niño3.4 SST absolute anomaly

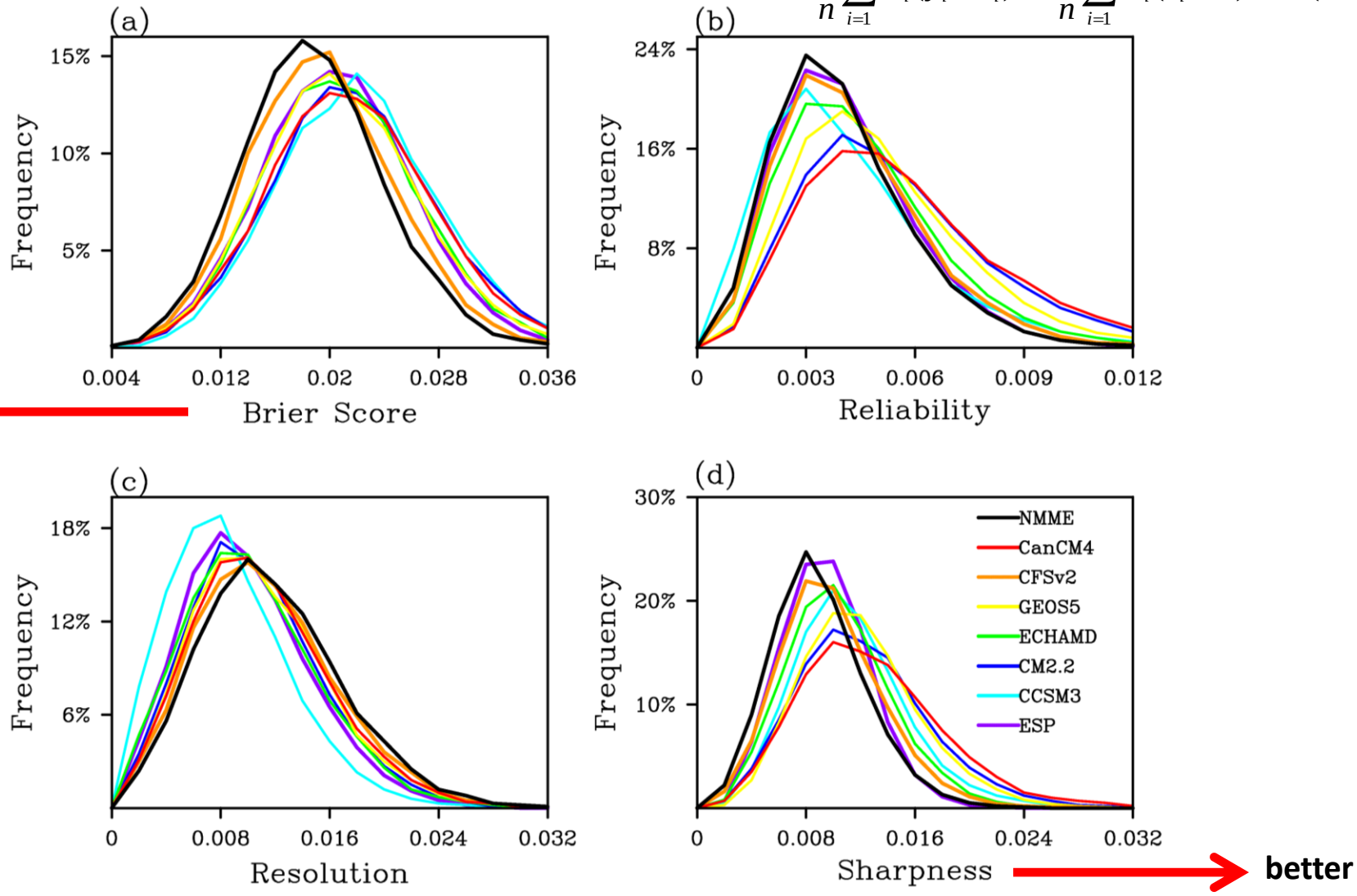


➢**Climate models have more chance to predict a drought condition (no matter a correct forecast or a false alarm) when the antecedent SST anomaly is larger.**

Yuan and Wood, GRL, 2013

Probabilistic drought forecasting: Reliability

$$BS = \frac{1}{n}\sum_{i=1}^{I} N_i(y_i - \bar{o}_i)^2 - \frac{1}{n}\sum_{i=1}^{I} N_i(\bar{o}_i - \bar{o})^2 + \bar{o}(1-\bar{o})$$



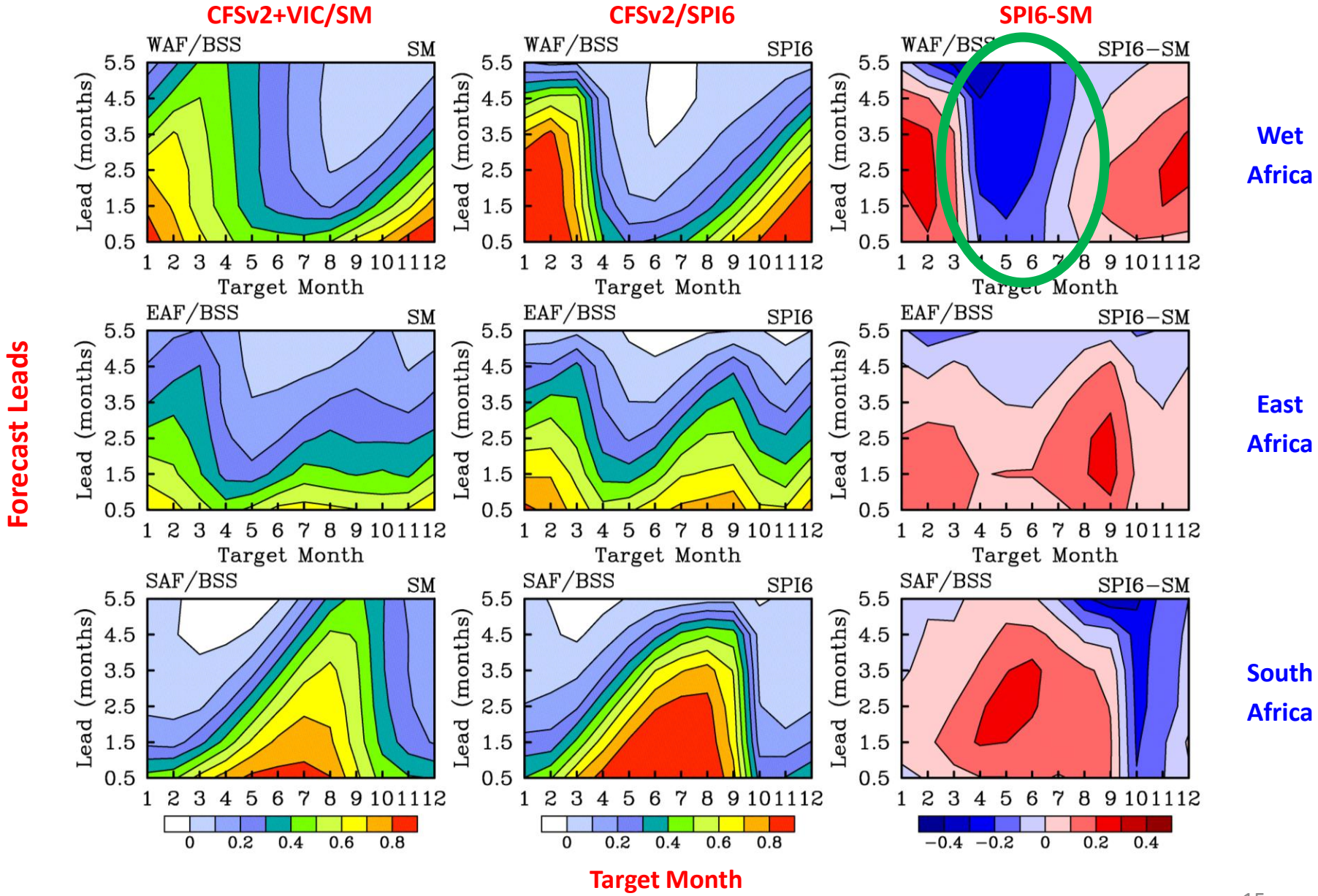
better ←

→ **better**

Reliability is important for a skillful probabilistic drought onset forecast

Yuan and Wood, GRL, 2013

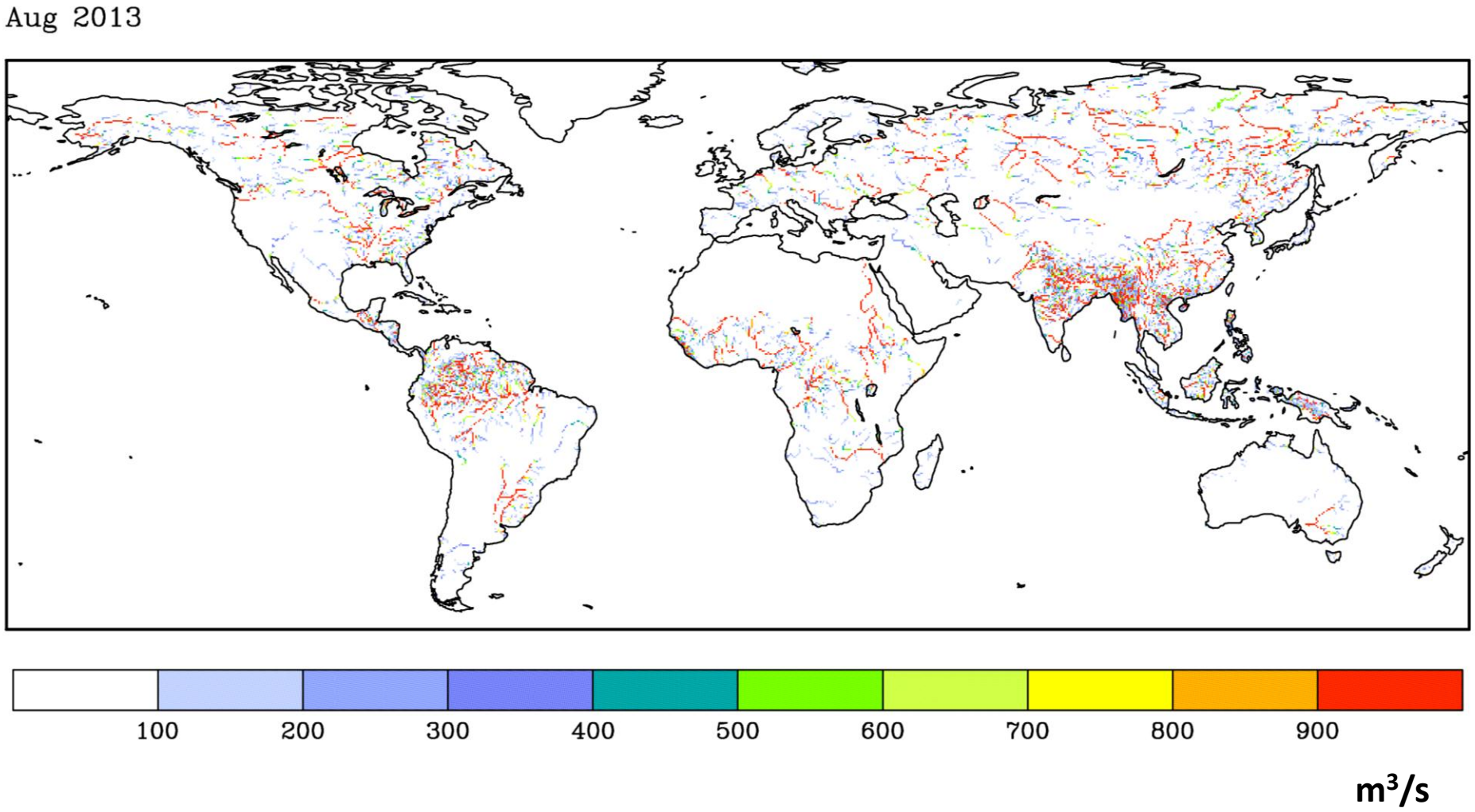
Probabilistic drought forecasting: Seasonality



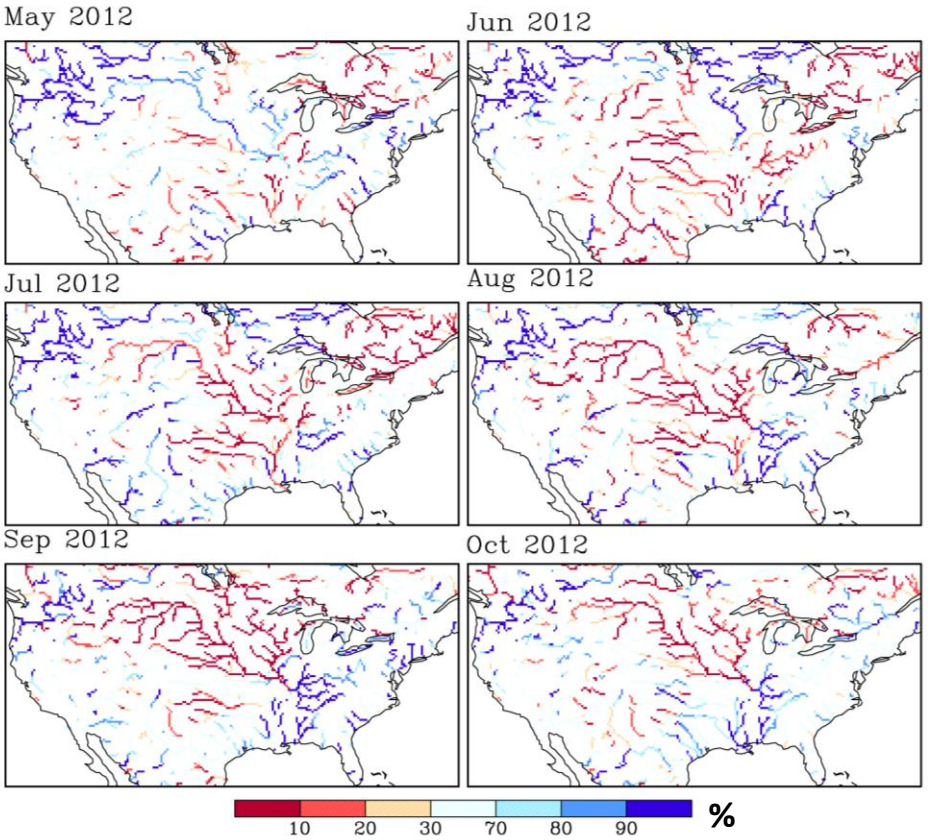
Brier Skill Score (BSS) for drought forecast over different areas of Africa

Yuan et al., JHM, 2013

VIC global streamflow monitoring

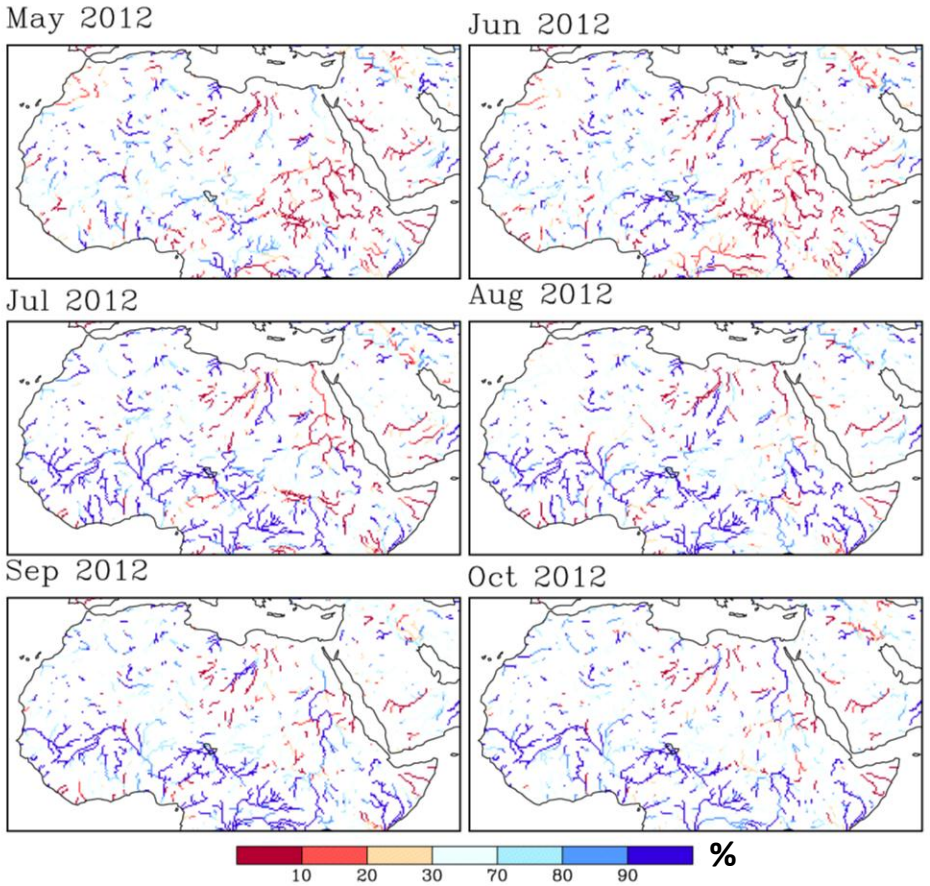


Hydrologic drought and wet spell



2012 North American Drought

2012 West Africa Flood



VIC simulated streamflow percentile

(climatology period 1948-2010)

Summary

- For most GEWEX basins, the highest actual precipitation predictability occurs in winter (DJF), but the highest potential predictability occurs in spring (MAM).
- NMME-VIC has more advantage against climatology for predicting (soil moisture) droughts than for predicting wet spells, especially at short leads. One possible reason for such asymmetry is that wet soil has longer memory in the forecast system.
- Less than 30% of the global drought onsets (at 1-degree) can be detected by climate models. The missed events are associated with weak antecedent ENSO signal. NMME only adds value over those ENSO-affected low latitude areas, indicating the challenge in implementing a deterministic global drought forecasting system.
- Reliability and seasonality are very important for probabilistic drought forecast .
- Global routing facilitates the monitoring and forecasting of global hydrologic droughts.

***Thank you for your attention*!**